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Can No Antitrust Policy Be Better Than Some Antitrust Policy?

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Partial antitrust policy may lead to less competitive market structures than the total absence of such policy. There may sometimes even be a case for the government providing incentives for particular forms of merger.

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Summary findings

Mattoo examines how the market structure is likely to evolve where there is multistage oligopolistic production — and what the implications of this are for antitrust policy.

Mattoo treats the decision to merge across or within stages of production as endogenous. He shows that when firms at a particular stage of production are relatively dominant, simultaneous merger decisions are conducive to competitive vertically integrated outcomes, while sequential decisions are not.

The persistence of nonintegrated market structures may be explained by the existence of equally dominant firms that make merger decisions sequentially. The credible threat of retaliatory merger may deter both socially desirable and undesirable forms of merger.

What implications do Mattoo's findings have for antitrust policymakers?

For one thing, partial antitrust policy may lead to less competitive market structures than the total absence of such policy, because policy barriers to horizontal mergers only at a particular stage of production eliminate the deterrent effect of retaliatory merger. For example, if the two stages of production are located in countries with different antitrust legislation, a policy that protects consumers from domestic mergers may ultimately hurt them by rendering foreign mergers more attractive.

When the equilibrium market structure does not contain socially undesirable mergers, there is no need for antitrust (or competition) policy.

Moreover, there may sometimes be a case for the government actually providing supplementary incentives to encourage particular forms of merger — as, for instance, when the threat of retaliatory merger deters socially desirable vertical mergers.

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Can no anti-trust policy be better than some anti-trust policy?

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It has for long been recognised that modelling the merger decision as endogenous is likely to be fruitful. As Salant, et al. (1983, p. 374), wrote, "This...approach is exciting because it would permit predictions about which mergers are contained in the set of equilibria and which mergers will never occur. Antitrust authorities need not concern themselves with blocking mergers outside the equilibrium set, since market forces would prevent their occurrence; for the same reason, the government could not cause such mergers to occur (without using supplementary incentives) even if they would be socially desirable. Finally, such models may ultimately help us understand the evolution of industry structure over time as coalitions form and regroup."

Much of the existing literature on horizontal and vertical merger reveals two inadequacies. Merger is usually treated as an exogenous change in the market structure, and each form of merger is treated as the outcome of an independent decision.[1] While there have been several recent attempts to treat the decision to merge as endogenous, there has so far been no analysis of multistage oligopolistic production where both horizontal and vertical merger are options. This paper seeks, not only to *endogenise* the decision to merge, but to examine which, if any, of the two forms of merger will take place when *both* are possible.

Allowing for the possibility of both horizontal and vertical mergers enables us to pose the following question: is one form of merger universally more likely to occur in the absence of restraining legislation, or does the result depend on factors such as the initial market structure and the manner in which various participants move? This is of particular interest because there is a general presumption that horizontal integration leads to an anti-competitive outcome (in the absence of significant economies of scale), while vertical integration is likely to be pro-competitive (unless there is significant vertical foreclosure).

These issues have wider significance since they relate to the more general problem of coalition formation, relevant, for instance, to multinational enterprises (MNEs) operating in the extractive industries. Thus while there is evidence of MNEs forming joint ventures and colluding with each other - witness the cartels of raw material and oil producers - there is also considerable evidence of MNE's in oligopolistic situations resorting to vertical integration either as a device for pre-empting a rival or for punishing a rival for a similar move undertaken elsewhere (see Caves (1996) for a survey of this literature). As noted, for instance by Scherer (1980, p. 90): "When vertical integration induced by fewness of supply sources thins the market further, other buyers may be stampeded into integrating as well despite appreciable scale economy sacrifices. Dynamics of this sort can be observed in the histories of the U.S. and European refrigerator-freezer industries, the U.S. automobile industry, and the movement by American steel makers into iron ore mining."[13]

The observed variations in behaviour - from collusion at a particular stage of production to successive vertical integration of oligopolists at different stages of production - have prompted several different explanations. These include technological features, the importance of transactions costs at different stages of production, and the manner in which agents can best respond to the riskiness of an environment characterised by uncertain demand or input supplies. This paper focuses purely on the interdependence of oligopolistic producers operating at each stage of production.

The importance of two features in determining the emergent market structures is highlighted: first, whether or not firms at a particular stage of production are relatively dominant, and, second, whether firms move simultaneously or sequentially. Firms at a particular stage of production are *relatively dominant* when they have the option of merging with each other and firms at the other stage of production do not. Empirically, relative dominance may be

observed where firms at a particular stage are situated in a country or sector where anti-trust policy does not pose impediments to merger.

Merger moves can be regarded as *simultaneous* or as *sequential*. The former implies that all firms must make an offer of merger, including its terms, at the same time. In the latter case, firms move in alternate sequence over one or more rounds of moves. The appropriate solution concepts in the two cases are, respectively, the Nash equilibrium and the sub-game perfect equilibrium. Empirically, simultaneity may be a way of depicting the situation in markets in which *if* there were first movers in the merger game, they would gain significantly at the expense of others.

The basic results can be summarised as follows:

1. When firms at one stage of production are relatively dominant, whether the equilibrium market structure is pro-competitive (i.e. vertically integrated) or anti-competitive (horizontally integrated) depends on whether the dominant firms act simultaneously or sequentially. Simultaneous behaviour is conducive to competitive outcomes. The result arises because the payoffs of the relatively dominant firms have a "prisoners' dilemma" structure: in the simultaneous move merger game, there is a dominant strategy Nash equilibrium in which each firm independently chooses vertical integration, and the integrated units compete fiercely against each other. This outcome is strictly inferior for the relatively dominant firms than horizontal merger with each other, but the latter outcome only emerges as a sub-game perfect equilibrium in a sequential move merger in which each firm can base its decision on the choices of the other.

2. When all firms are equally dominant, and merger moves are sequential, the most likely outcome is no merger at all. Even though each merger is in itself profitable, ceteris paribus, the credible threat of retaliatory merger creates sufficient disincentives to initiating either form of

merger. Horizontal merger of firms at one stage is deterred because it would optimally provoke a merger also of firms at the other stage, leading to a situation of successive monopoly, which results in a decline in industry profits because it is highly inefficient. Vertical merger between two firms is deterred because it would optimally provoke a vertical merger also of the other two firms, leading to a situation of low cost duopoly, which also results in a decline in industry profits because it is highly competitive.

The most striking implication for policy is that partial anti-trust policy may lead to less competitive market-structures than the total absence of such policy . The reason is that a policy which creates barriers to horizontal merger only at a particular stage of production, eliminates the deterrent effect of retaliatory merger. In particular, if stages are located in countries with differing anti-trust legislation, a policy which protects consumers from domestic mergers may actually hurt them by rendering foreign mergers more attractive.

It is also noteworthy that there may sometimes be a case for the government actually providing supplementary incentives to encourage particular forms of merger. This would be the case when the threat of retaliatory merger deters socially desirable vertical mergers.

In the next section the basic assumptions of the model are described. Section II contains a discussion of the appropriate solution concept, after which the alternative market structure equilibria are examined in Section III. Section IV discusses some implications of the analysis.

I. THE MODEL

There are two stages of production - the first can be thought of as 'mining' and the second as 'refining' of a mineral. There can be three kinds of firms: 'mines' which produce crude,

'refineries' which produce the final good, and those which do both, vertically integrated firms (VIFs). The following symbols are used:

Final good producers (refineries)	R_1, R_2
Intermediate good producers (mines)	M_1, M_2
Vertical integration (VI)	(M_1+R_1), (M_2+R_2)
Horizontal integration (HI)	(M_1+M_2), (R_1+R_2)

The incentive to integrate vertically arises from the desire to circumvent the mark-up over variable cost charged in the intermediate good market. By eliminating the inefficiency arising from double-marginalization, the VIF effectively gains a competitive edge in the final good market, so that the constituent firms together gain at the expense of the rest of the industry.[2] The incentive to integrate horizontally at either stage of production arises from the increase in the monopoly power that such integration involves.[3] Through integration, Cournot duopolists gain by internalizing the inframarginal losses that they impart to each other when they decide on output levels independently.

There are several choices to be made regarding the depiction of the merger process. The whole process is viewed as a two stage game: first, a stage in which various forms of merger are considered and accomplished, described by assumptions (A6) to (A10); second, the market stage, where the game is played according to Cournot rules between firms at the same stage of production, while firms at the earlier stage of production are price leaders vis-a-vis those at a later stage of production, described by assumptions (A1) to (A5).

First, regarding the demand conditions it is assumed that:

A1. The final demand function is linear. The inverse demand function is of the form $p = 1 - Y$, where p is the price of the final good and Y the total output of the final good.[4]

As work by Seade (1985), Bulow, et al. (1985) and others has shown, linearity does impose a significant restriction in oligopolistic situations. The assumption is used here to obtain explicit solutions for profits of the firms under different market structures.

Regarding the production conditions it is assumed:

A2. The production function can be written (through appropriate choice of units) in the form $y = x$, where y is a refinery's output of the final good and x the input of crude. Mines produce the intermediate good, "crude", costlessly. Refining uses solely the input from the mine. Hence, the marginal cost of an unintegrated refinery is the price of crude charged by the mine, while the marginal cost of a vertically integrated firm is zero.

Note that the total production costs in both the vertically integrated and the unintegrated case are zero – i.e., the mine mark-up in the latter case is not a cost of production, but only a transfer from the refinery to the mine. There is no significant loss in generality in assuming away costs of production when there are no economies of merger. The assumption of fixed coefficients technology makes it simple to obtain the derived demand for crude - although it does impose a significant restriction compared to allowing for variable proportions (see Waterson (1982) for a more general treatment). Given this assumption, the existence of other inputs can be ignored without further loss of generality, provided they are supplied competitively and produced using constant returns to scale technology.

A3. There is a single period (one-shot) homogeneous good Cournot duopoly at each stage of production. There is complete information regarding the demand function and the cost functions of all firms, and this is common knowledge.

A4. Refineries exercise market power only vis-a-vis consumers and not vis-a-vis the mines, whose price they take as parametrically given; i.e. mines act as "price leaders" vis-a-vis the unintegrated refineries.

This assumption is needed to render the non-merger situation determinate and thus provide a clear reference point for establishing the nature of outside options. There is as yet no satisfactory theory of how intermediate good prices are determined in situations of successive monopoly or oligopoly. Assumption (A2) is frequently made in the literature and is reasonable if the decisions of the intermediate good producers precede those of the final good producers (see Lewis et al. (1986) and Salinger (1988)).[5]

A5. VIFs make the Cournot conjecture about the behaviour of rival final good producers; the VIFs do not buy or sell the intermediate good.

These assumptions are made to simplify the analysis. Assuming that the VIF withdraws from the intermediate good market is in conformity with results obtained in the literature.[6] Given our assumptions, it is possible to show that a VIF makes greater profits by processing any single unit of the input itself and selling the resultant output on the final good market than by selling the unit of input to rivals.[7] Strangely, it turns out to be more difficult to show that a VIF would not buy the input in order to raise rivals costs even though it can produce it more cheaply itself. However, this possibility raises complex issues about the nature of firms' conjectures from which we choose to abstract in this paper.[8]

A6. The decision to merge involves only two firms, is irreversible and involves a binding commitment to maximise the joint profits of the constituent firms.[9]

The utilities of the owners of firms are identical to the profits of the firms, which can be distributed freely within a merged unit - i.e. utility is transferable.

The distribution of profits post-merger is decided between participating firms before the merger, and it is possible to write binding contracts to enforce this. Both the negotiations preceding the merger and the writing of contracts are accomplished costlessly.

Note that the merged entity behaves essentially like a multi-plant firm under the control of a particular player in a non-cooperative game. Firms have available the options of forming alternative mergers when bargaining over the profits from a particular merger. Whether they have the time to use these options will depend on which of the following is assumed:

A7(a). The merger stage is a one shot simultaneous move game, followed by a one shot game in the market stage.

or (b). The merger stage is a sequential move game, followed by a one shot game in the market stage. Firms move alternately in the merger stage playing one or more rounds of moves, and enter the market stage either (i) when two firms have merged, and the other two have had an opportunity to react by merging or not merging, or (ii) when each firm has had an opportunity to react to the decision of the other firms not to merge.

How these alternative assumptions influence the nature of options available to firms will be discussed later. But note that assuming the firms move simultaneously in the one-shot merger stage implies that if they fail to agree on the terms of a merger, they only have the option of remaining unmerged. When the merger stage is a sequential move game, Assumption (A7b) ensures that merger is not a precondition for entry into the market stage.

Regarding the costs of merger itself, the following weak assumption is made:

A8. If a particular merger and staying unmerged offer the same payoffs to a firm, it prefers to stay unmerged.

If a particular merger A (horizontal or vertical) offers a firm even slightly (ε) greater profits than staying unmerged, UI, or another merger B (horizontal or vertical), the firm prefers A to UI and B.

This assumption implies that the price at which a firm will accept to merge must be ε above the alternative, and this turns out to be an important tie-breaking rule (an alternative would be simply to assume that the transactions costs of implementing a merger are ε).

In the sequential move merger games, only the following weak assumption is made regarding the time preference of firms and the termination of the merger stage:

A9. Between two identical outcomes at different points of time, the firm prefers the earlier one.

The firms do not want to delay indefinitely the market stage in which the payoffs are obtained.

This "negligible" time preference simply means, in the sequential case, that firms would prefer that any specific eventual equilibrium be reached after a minimum number of offer-response rounds.

The numerals 1 and 2 are used to distinguish between the two mines and the two refineries, and the following simplifying assumption is made:

A10. Mine 1 and refinery 1 consider vertical merger (VI) only with each other, as do mine 2 refinery 2, i.e. diagonal mergers are ruled out.

The crucial issue is as to how the payoffs *within* the merged unit are decided. To begin with, the profits accruing to various units under the different market structures can be calculated and are depicted in Table 1 (note that we suppress the negligible cost of delay, if any, from our computed profits). Given assumptions (A1) to (A5) it is straightforward to obtain these values from the standard Cournot duopoly model and the mathematical detail has been relegated to the Appendix.

[TABLE 1]

The initial situation, with no integration, is depicted in row (4). To see the intuition for the levels of profits and prices associated with different outcomes, we can identify two types of externalities that arise between firms in this model: a horizontal externality between firms at the same stage of production, and a vertical externality between firms at different stages of production. The horizontal externality is that any decision by a mine (or refinery) to expand output, leads to a decline in prices which reduces the profit of the other mine (or refinery). However, Cournot duopolists, which maximize their own profits, do not take their rivals' incremental profits into account, and therefore tend to overproduce relative to the joint-profit maximizing level of output. The vertical externality is, first, that any decision made by a refinery that increases demand for the intermediate good generates increased profit for mines. Similarly, any decision by a mine to expand output, reduces crude prices and increases the profits of refineries. However, neither the refineries nor the mines, which maximize their own profits, take into account the incremental profits of firms at the other stage of production, and therefore tend to make decisions which lead to underproduction relative to joint-profit maximizing levels of output.

HI between two mines (or two refineries) benefits participants (for any given structure of the rest of the industry) because they internalise the inframarginal losses that they impart to each other when they decide on output levels independently, so that the merged unit produces the monopoly level of output. But the merger hurts firms at the other stage because the resultant price increase worsens the negative spillover on them.[10] VI between a mine and a refinery benefits participants (for any given structure of the rest of the industry) because it eliminates one of the two successive mark-ups (or double-marginalization) and leads to an expansion of output to the efficient level. But it hurts rivals because it worsens the negative effect that they suffer through the reduction in prices caused by increased output.

It is well known that with fixed factor proportions and successive monopoly (rather than successive duopoly), double marginalization leads to a price in excess of the monopoly price that would occur with VI (Tirole, 1989), lowering both profits and consumer surplus. And this is what we in fact see in the first outcome in Table 1: if the horizontally integrated firms were permitted to then vertically merge into a monopoly industry, price would be 0.5, a price between that in outcomes 4 and 5.

For the industry as a whole, fragmentation (outcome 4) serves to dampen competition and raise prices above those that would be charged by a vertically integrated Cournot duopoly (outcome 7), toward the monopoly price. Indeed, the price with fragmentation is a little bit higher than the monopoly price.

As expected, final good price is highest in outcome (1), i.e. HI at both stages, and diminishes (or stays unchanged) down through the rows, being least in outcome (7), i.e. VI of successive duopolists. It is straightforward to show that social welfare, measured as the unweighted sum of consumers surplus and firms profits, is least for outcome (1) and increases through to outcome

(7). This confirms, in the context of the model, that vertical integration is socially more desirable than horizontal integration. Profits are maximized by complete integration, but attention is restricted to single mergers.

II. SOLUTION CONCEPTS

For a merger to be consummated, we need only to specify that for the two firms involved the opportunities on the merger frontier exceed those from, ceteris paribus, the alternatives (not merging or selecting an alternative merger). Then they would merge and share the gains of moving to the frontier in some fashion which is Pareto superior relative to both neither merging nor selecting an alternative merger. For concreteness, we wish to show the profits of each firm, to demonstrate the gains from merger. To implement a functional form for the profit sharing rule, we use a particular interpretation of the well-known Nash bargaining solution to the problem (qualitative results are insensitive to this formulation).[11] This solution concept will be seen to imply, in the present context, a simple sharing rule: profits from each merger are divided equally between the participants, unless either party can obtain more from an alternative merger or by staying unmerged.

The Nash bargaining solution to the two-player/one-cake problem involves maximising:

$$(\pi_i - s_i)(\pi_j - s_j)$$

subject to $\pi_i + \pi_j = \pi_{ij}$,

and $\pi_i > s_i$, $\pi_j > s_j$, $\pi_i > \pi_{oi}$, $\pi_j > \pi_{oj}$.

where:

π_{ij} are the total profits of the merged firm,

π_i , π_j are the payoffs to individual firms within the merged unit,

s_i , s_j are the status quo points,

π_{oi} , π_{oj} are the outside options.

It is necessary to establish the nature of (a) the 'status quo' point which fixes the origin with respect to which the maximisation exercise is carried out, and (b) the 'outside options' which fix the minimum profits acceptable to the two parties, and are only relevant if the unconstrained Nash solution were to allocate profits to one party below this level. Here, as in Binmore (1985), the distinction lies in that the outside option is something to which the firm can voluntarily withdraw while the status quo is the payoff which the firm earns if the bargaining process continues unsuccessfully for an indefinite period, i.e. the 'disagreement point'. Since the situation has been depicted as a two stage game, and the market stage is only entered after the negotiation stage, the firms are not operating as such until the bargaining has been concluded. So it is appropriate to regard the firms as earning nothing while the bargaining process continues inconclusively, therefore I put $s_i = s_j = 0$.

The outside options, π_{oi}, π_{oj} are the profits earned either if the firm stays unmerged or if it enters into alternative mergers, depending on whether the latter option is open to it when it is bargaining. This will depend on the specification of the merger process, and for each of the following situations an appropriate definition will be suggested.

The crucial issue is how outside options, i.e. the possibility of forming alternative mergers or staying unmerged, affect the payoffs within the merged unit. There is an obvious interdependence here, in that a firm's potential profits from one merger are an outside option for it in another merger and vice versa. The next section is devoted to the solution of this problem.

III. ALTERNATIVE MARKET STRUCTURE EQUILIBRIA

In this section, I establish the nature of market structure equilibria under alternative assumptions about the temporal structure of the model, i.e. variants of assumption (A7). This is done in two stages. First, a two-person non-cooperative game between the mines is studied. This is done by assuming that the input producers or mines, M_1 and M_2, are *relatively dominant*, i.e. they have the option of merging horizontally while the final good producers or refineries, R_1 and R_2 do not. It will also be convenient to assume that it is the relatively dominant mines which can initiate integration with the refineries, and that the latter are 'passive'. After this we present a more general case, in which all firms are equally dominant. This marks a shift from the earlier "two-person game" to a "four-person game." In this case, for simplicity, attention will be restricted to the situation where merger moves are sequential.

A. *Relatively dominant mines, passive refineries: simultaneous moves*

In this section, the consequences of assumptions (A1) to (A10) including (A7a) are examined: relatively dominant mines, M_1 and M_2 move simultaneously in the one shot merger stage of the game, after which there is a one-shot market stage.

Each mine can do one of three things: (i) remain unintegrated, UI, (ii) merge with a final good producer, VI, - it is assumed that M_1 considers merger with R_1, and M_2 with R_2, or (iii) offer to merge with the other mine - the offer is represented by the notation "HI?". Each mine simultaneously makes an offer of merger, including its terms, to one other firm. If the offers match both in the choice of firm and the terms, they merge, otherwise they stay unmerged. There is no possibility of switching to another firm: the only outside option is to stay unmerged. The matching offers, which are also the payoffs from successful merger, are calculated using the Nash bargaining solution: as if they were the outcome of actual bargaining with only non-merger

profits as outside options.[12] In effect the four-person/four cake problem has been broken into four two-person/one-cake problems.

If M_1 chooses VI, then while it is bargaining with R_1, it only has an outside option of staying unmerged, given the one shot nature of the game. There are two possibilities: either M_2 and R_2 do not merge, i.e. outcome 5, or they also merge, i.e. outcome 7. In the former case the profits to be divided are 0.1837, and the outside options for M_1 and R_1, i.e. their profits from staying unmerged, are 0.0494 and 0.0741, respectively (see outcome 4). These are strictly less than the shares determined by the unconstrained Nash bargaining solution, 0.0918 to each. In the case of outcome 7, the profits to be divided are 0.1111, and the outside options for M_1 and R_1 are 0.0204 and 0.0408, respectively (see outcome 6), which are also strictly less than the shares determined by the unconstrained Nash bargaining solution, 0.0555 to each. The payoffs to M_2 and R_2 from outcomes 6 and 7 can be similarly calculated. Table 2 depicts the payoffs to M_1 and M_2 from each of their different actions.

[TABLE 2]

The parenthetical terms in Table 2 refer to the outcomes as presented in Table 1. The first item in each box is the payoff to M_1 and the second the payoff to M_2. These payoffs, anticipated by the firms in their merger decisions, have a "prisoners' dilemma" structure: there is a dominant strategy Nash equilibrium: outcome 7 (M_1+R_1, M_2+R_2), i.e. both M_1 and M_2 integrate forward into the final stage, and compete more fiercely against each other. This is strictly inferior for them than outcome 2 (M_1+M_2, R_1, R_2), i.e. horizontal merger, and even outcome 4, i.e. no merger, but neither can risk offering HI? or choosing UI in a one shot simultaneous move game. Hence:

PROPOSITION 1: *Given assumptions (A1) to (A10) including (A7a) (i.e. simultaneous moves), with relatively dominant mines and passive refineries, the unique Nash equilibrium involves vertical integration of each intermediate good producer with a final good producer.*

The realism of modelling merger decisions as a one-shot simultaneous move game may be questioned since it is almost always possible for other firms to retaliate. However, retaliation may take time. The distinction made in the paper between simultaneous and sequential move games is based on the relative lengths of time of the merger and market stages. In some cases, first movers in the merger stage of a game can make significant gains in the product market before others are able to conclude negotiations on a retaliatory merger. Thus no one can afford to wait for others to move first, so firms may be stampeded into merging - even though multiple mergers may lead to lower profits for everyone.

B. *Relatively dominant mines, passive refineries: sequential moves*

All the assumptions of the previous section are retained except (A7a), which is replaced by (A7b). The merger stage is now assumed to be a sequential (alternating) move game of possibly several rounds played once, which continues till market structure equilibrium (if it exists) is reached. The decision to merge is irreversible, while the decision not to merge is reversible until the merger stage is terminated. Each mine has one additional element in its choice set: it can *accept* an offer from the other mine to merge horizontally - denoted by "HI!".

To see how the game proceeds, assume M_1 moves first. As in the previous game, it can do one of three things: (i) remain unintegrated, UI; (ii) merge with a final good producer, VI; or (iii) offer to merge with the other mine, HI?. If M_1 has chosen UI, then M_2 has available to it the same three options: UI, VI, HI?. If, however, M_1 has chosen VI, then M_2 can choose between

only UI and VI, and the merger stage concludes once it has chosen either option (see A7(b)(i)). If M_1 has chosen HI?, then M_2 again has three options open to it: UI, VI, HI!. If it chooses HI!, the merger stage concludes. Except in the three conclusion scenarios, (VI,UI), (VI,VI), (HI?, HI!), after M_2's move M_1 has an opportunity to move again. If the previous choices of both had been UI, and if M_1 chooses UI again, then the merger stage concludes - since each firm has had an opportunity to react to the decision of the other firm not to merge (A7(b)(ii)). The other possible paths down the game tree can be worked out similarly.

In this game, as distinct from the simultaneous one, a mine, when bargaining over the terms of a particular merger, may have the *outside option of forming an alternative merger*, in addition to the one of staying unmerged. In particular, M_1, by virtue of moving first, has the outside option of offering HI to M_2 when it is considering VI with R_1. But if M_1 has chosen VI, M_2 no longer has the outside option of HI with M_1 when considering VI with R_2.

First note that outcomes (5) and (6) will never be observed as equilibrium market structures, unless there are partial barriers to VI. If either M_1 or M_2 chooses VI, it is in the best interests of the other to do the same. E.g. compare from the point of view of M_2 and R_2, outcomes 5 and 7, in which M_1 and R_1 have *already* merged; they can earn 0.0204 and 0.0408 respectively if they stay unmerged (5) and 0.0555 each if they too VI (7). The latter is obtained from the distribution of 0.1111 from VI, *given* the merger of M_1 and R_1 (with outside options of 0.0408 for M_2 and 0.0204 for R_2 if they stay unmerged). Clearly VI is preferable to staying unmerged. Thus outcome 7 (M_1+R_1, M_2+R_2) is a Nash equilibrium, in which the total expected payoff to each vertically integrated unit is equal to 0.1111.

Now consider outcomes (2) and (7), which must be treated differently from Section IIIB. The most M_1 can obtain from VI with R_1 is (0.0833-ε). To see this note that the least R_1 is

assured of is 0.0278, which are its profits from staying unmerged given that the mines have merged (outcome 2). By assumption (A8), regarding the costs of merger, R_1 will want at least ε more to induce it to accept VI rather than stay unmerged. The size of the cake obtainable from VI is 0.1111, as shown above. Hence, the most M_1 can get is 0.1111-(0.0278+ε), which gives the above expression.

If M_1 offers HI? to M_2, the latter can accept HI!, choose UI or initiate VI with R_2. At this stage, with M_1 unmerged, the most M_2 would get from VI is also (0.0833-ε) (which is greater than the most available from UI, i.e.0.0741). After taking into account their maximum possible outside options, the Nash bargaining solution divides the profits from HI, 0.1666, equally between M_1 and M_2, i.e. each gets 0.0833 from outcome 2. The second mover status means that M_2 gets less than M_1 if the latter chooses VI, but does not affect the sharing of profits from HI.

[TABLE 3]

Given the payoffs from outcome 2, the payoffs to the two mines from outcomes (5), (6) and (7) can be similarly calculated and are presented in Table 3. The choices by M_1 in period 3 that do not have a final outcome as the end, lead either to previously achievable outcomes in later periods or indefinite delay in the attainment of market structure equilibrium and entry into the market stage. These are ruled out by the assumption of weak time preference (A9).

Outcome 7 (M_1+R_1, M_2+R_2) continues to be a Nash equilibrium (albeit, as we shall see, not sub-game perfect) in this game as well, as noted above. If either mine chooses VI, it will expect the other to do the same, since it is in the latter's best interest to do so. But this involves less

profits for the mines than outcome 2 (M_1+M_2, R_1, R_2). Given the assumption of weak time preference (A9), M_1 will straightaway offer HI? and M_2 will accept HI!. Hence:

PROPOSITION 2: *Given assumptions (A1) to (A10) including (A7b) (i.e. sequential moves), with relatively dominant mines and passive refineries, the unique sub-game perfect equilibrium involves horizontal merger of the mines.*

It is evident that if the option of VI is not open to a particular mine, then the other mine will choose VI, e.g. M_1 prefers (5) to (2). Without the threat of retaliatory VI, the gains from VI outweigh those from HI.

C. *Mines and refineries are equally dominant: sequential moves*

In this general situation, each firm can offer the relevant other firm HI? or VI?, accept an offer HI! or VI!, or choose UI. The merger stage is again assumed to be a sequential (alternating) move game of possibly several rounds played once, which continues till market structure equilibrium (if it exists) is reached, after which there is a one-shot market stage. The important difference from the previous section is that now the refineries can offer and accept HI as well. The similarity is that the firms can base their decisions on the choices of other firms. There are several different ways of describing this game, for instance by specifying a precise order in which players move. However, the object here is to obtain fairly general results so that little specific structure is provided. The first thing to be established is that:

LEMMA 1: *The threat of retaliatory merger is credible, i.e. if any two firms merge, it is in the best interests of the other two firms to do the same.*

For example, say M_1 and M_2 have merged. If R_1 and R_2 stay unmerged they earn 0.0278 each (Table 1: outcome 2). If they merge (outcome 1) the Nash bargaining solution gives them each 0.0313, greater than their identical outside options of staying unmerged. This can be established for each of the other forms of merger. It emerges that outcome 1 (M_1+M_2, R_1+R_2) and outcome 7 (M_1+R_1, M_2+R_2) are two of the Nash equilibria in this game, which implies that the threat of retaliatory merger is credible. Asymmetric outcomes, like outcome 2 (M_1+M_2, R_1, R_2) and outcome 6 (M_1, R_1, M_2+R_2), etc. will never be observed as market equilibria.

It has been established that outcomes (2), (3), (5) and (6), involving partial merger, cannot be final equilibrium outcomes, while (1) and (7) are both Nash equilibria. However, it is possible to show that the maximum payoff for each firm is from outcome (4), i.e. no merger at all - an outcome which also maximises industry profits (given the available choices). On this basis, we seek to establish that:

LEMMA 2: *The credible threat of retaliatory merger deters all mergers.*

We need to demonstrate that each firm prefers to stay unmerged, provided no other firms merge, to merger given that other firms will also merge. Consider M_1. The most it could get from merger with M_2 is 0.0695. This is the difference between 0.1250, the total profits from merger (outcome 1), and 0.0555, the profits M_2 can be sure of even if M_1 has already merged with R_1 (see Section IIIC).

The best possible outside option for M_1, when it is bargaining with R_1, is therefore 0.0695. Since the profts that M_1 and R_1 would obtain from merger are 0.1111 (outcome 7), the outside option constraint is binding for M_1, so it can expect to get 0.0695. Thus M_1 would get less from

merger with either M_2 or R_1 than what it could get from staying unmerged if no one else merges, 0.0741 (outcome 4).

Similar reasoning establishes that M_2, R_1 and R_2 can each do better by staying unmerged provided no one else merges. So the optimal strategy for each firm is simply to refrain from merger provided no one else merges, and to participate in a retaliatory merger the moment someone else merges. Thus, each firm in its turn will choose UI, and given Assumption (A7b), they will enter the market stage once each has had an opportunity to react to the decision of the others not to merge. If any two firms were to merge, Assumption (A7b) would ensure that the merger stage would continue until the other firms had a chance to react. In sum, the threat of retaliatory merger will be a credible and effective deterrent to any merger.

PROPOSITION 3: *Given assumptions (A1) to (A10) including (A7b) (i.e. the firms move sequentially), with both mines and refineries equally dominant, the unique subgame perfect equilibrium involves no merger at all.*

Comparing this with the previous section, it is evident how *potential countervailing power* can lead to relatively pro-competitive outcomes, i.e. it is an effective deterrent to the anti-competitive horizontal merger. It is the fear of the unprofitable successive monopoly situation which deters merger, because the gains from reducing competition within a stage are more than offset by the losses from increased prices at the other stage. But there is also a deterrent to the pro-competitive vertical merger. Here it is the fear of highly competitive low-cost duopoly situation that deters merger. The gains from eliminating the mark-up over marginal costs are more than offset by the expansion in the rival's output.

It is also possible to establish:

PROPOSITION 4: *Given assumptions (A1) to (A10) including (A7b), i.e. firms move sequentially, if two specific firms are prohibited from merging with each other, but all other two firm combinations are permitted, then there is one unique merger which will occur, and it involves the merger of the other two firms.*

From an examination of situations where two firms cannot merge with each other, it emerges that in each case the symmetric merger is most attractive, i.e. if vertical merger between two firms is not possible, the vertical merger of the other two firms will occur, and not horizontal merger at each stage. And, as seen in Section IIIC, if horizontal merger at one stage is not possible, the horizontal merger of the other two firms will occur, not vertical mergers across stages. Thus the firms which cannot merge with one another will be left out of any merger. This is a consequence of the feature that retaliatory merger is most damaging, and the firms will choose the strategy which leaves no possibility of its happening.

IV. IMPLICATIONS OF THE RESULTS

This paper treated the decision to merge as endogenous in a simple model of two-stage duopolistic production. In the process, it demonstrated how equilibrium market structures depend on whether firms move simultaneously or sequentially, and whether firms at a particular stage of production are relatively dominant. Section IIIA showed that loss-making mergers could occur when firms have to take merger decisions *as if they were simultaneous*. This may be a reasonable depiction of circumstances in which the first mover in a merger game would reap significant benefits, so that no one can afford to wait for the others to move first. It is the prisoner's dilemma structure of payoffs which makes multiple merger difficult to prevent despite their negative impact on each firm's profits. McBride (1983), in a study of the U.S. cement industry, found evidence of multiple VI which led to a decline in industry profits.

Some situations are better approximated by depicting the firms as moving sequentially, so that they can base their decisions on the actual and rationally expected decisions of other firms. In these situations, I suggest, it is the relative dominance of some firms, or the absence of it, which will determine the outcome. Horizontal merger, or the formation of collusive oligopolies, is likely when the firms at one stage are relatively dominant and have no fear of the firms at another stage indulging in retaliatory merger - as in Section IIIB.

Vickers (1984) identified the possible strategic advantage to be had from non-integration. The results of Section IIIC, i.e. the equilibrium with no merger, point to a similar possibility. Firms refrain from VI which would commit them to competing fiercely against each other and hence lead to a decline in collective profits. They also refrain from HI because of the unattractiveness of successive monopoly. (The important assumption here is that successive monopoly will involve the highly inefficient double marginalisation and not a cooperative equilibrium between the monopolists at different stages.) The threat of retaliatory mergers is crucial. Since such mergers are Nash equilibria in the merger game, they constitute credible threats, and effectively deter any merger. This may explain both the persistence of non-integrated market structures in some situations and why firms do not proceed with ostensibly profitable mergers.

The implications for policy are significant. When the equilibrium market structure does not contain socially undesirable mergers, there is no need for anti-trust (or competition) policy. Furthermore, partial anti-trust policy, which creates barriers to horizontal merger only at a particular stage of production, may lead to less competitive market-structures than the total absence of such policy . For instance, if the two stages of production are located in countries with differing anti-trust legislation, a policy which protects consumers from domestic mergers may nevertheless hurt them by rendering foreign mergers more attractive.[14]

The threat of retaliatory merger does not always play a benign role. It can also deter socially desirable vertical mergers. In this case, it may be desirable for the government to provide supplementary incentives to encourage particular forms of merger.

FOOTNOTES

[1]E.g. Salant, Switzer and Reynolds (1983), Perry and Porter (1985), Farrell and Shapiro (1990), Kamien and Zang (1990, 1993) and Bloch (1995) are articles on horizontal merger in oligopolistic situations similar to the one dealt with here, while Greenhut and Ohta (1979), Salinger (1988,1989), Hart and Tirole (1990), Ordover, et al. (1990) and Innes and Sexton (1994) are concerned with vertical merger. Most of the work since 1990 has modeled the merger decision as endogenous. More general work on these lines can also be found in a new strand of the literature analyzing the formation of coalitions in non-cooperative games with spillovers (see Chatterjee et al. (1993) for an introduction to this literature, Bloch (1997) for a recent survey and Horn and Persson (1997) for an application of this approach to the study of mergers).

[2]The inefficiency could also be eliminated by the use of two-part rather than linear-price contracts (see Tirole (1989), p. 176). Vertical integration is defined here to include the possibility of implementing such two-part tariffs.

[3]An added incentive for such integration is that it may lead to synergies but this possibility will not be considered.

[4]Setting the slope and the intercept of the demand function equal to 1 does not lead to any loss of generality. The intercept matters only in relation to marginal cost, and no comparative statics are performed on either. Setting the slope equal to 1 only involves changing units.

[5]The assumption of successive market power gives input sellers an advantage over output sellers, leading to an asymmetric distribution of profits in non-integrated situations. It is possible to show that the results of this paper also hold for more symmetric assumptions about price determination - for instance, in a situation of mutually related market power where each of two complementary inputs is produced by a duopoly.

[6]Salinger (1988) concludes, on the basis of certain assumptions about the conjectures that the VIF makes, that the VIF does not participate in the intermediate good market. Ordover, et al. (1990) find that vertical foreclosure may be an equilibrium outcome when the final good is differentiated and firms compete in prices; they arrive at a conclusion similar to the above assumption for the case of homogeneous good Cournot duopoly. However, the question of how the VIF is likely to behave in the intermediate good market remains to be adequately answered (see Tirole, 1989, p. 195).

[7]A VIF earns price p from a unit sale in the final good market and a price q from a unit sale in the input market. The VIF makes the Cournot conjecture in the input market, i.e. it believes that other mines will not change their output in response to changes in its output. So it expects a unit of input sale to translate into an additional unit of final good sales by its rival refineries, and a unit reduction in crude sales to lead to a unit reduction of final good sales by its rival refineries. Thus shifting one unit of crude from sales on the crude market to its own refinery's final good sales is not expected to change the total output of the final good, the final good price or the revenue from inframarginal sales. From such a shift the VIF makes a net gain of $p - q$. This is positive, since for it to be profitable for an unintegrated refinery to operate, it is necessary that $p - q > 0$.

[8]While in the case of the VIF entering the input market as a seller there is a well-defined derived demand from the non-integrated refineries, it is difficult to define the appropriate conjectures that the VIF makes as a buyer. These issues are examined in detail in Mattoo (1990). See also Salop and Sheffman (1983) and Krattenmaker and Salop (1986).

[9]Most recent mergers have involved only two firms at any point of time. For instance, Scherer and Ross (1990, p. 153) find that "multifirm consolidations have been extremely rare in the United States since World War II."

[10]Mathewson and Winter (1997) present a similar argument in their analysis of buyer groups in a differentiated good model.

[11]The interpretation of the Nash bargaining solution used here follows Binmore (1985). The Nash solution has several appealing features. It has been given a rigorous non-cooperative game-theoretic justification (see e.g. Rubinstein, 1982), to complement the earlier behavioural (Harsanyi, 1956) and axiomatic (Nash, 1950) justifications. It is also fairly tractable, as compared to, for instance, the solution due to Kalai and Smorodinsky (1975). Finally, it has the attraction of ensuring that the bargain is efficient.

[12]For there to be a successful horizontal merger, both firms should choose HI?, while a mine can proceed with vertical merger unilaterally, subject to the requirement that it offers the firm being taken over adequate payoffs. E.g. if one firm chooses HI? and the other chooses UI, both remain unmerged, while if one firm chooses HI? and the other VI, the former remains unmerged and the latter merges forward. Since the refineries are passive, a 'take-over' may be a more accurate depiction of VI than a more symmetric merger. A firm taking over must pay the shareholders of the firm being taken over a share of the anticipated gain determined by the Nash solution. Even though the final good producers are passive, they can resist takeovers and choose to stay unmerged if the Nash equilibrium terms of the takeover are not suitable.

[13]See Bolton and Whinston (1993) for an examination of supply assurance concerns, which arise when several downstream firms compete for inputs in limited supply, in the context of a transactions costs model of vertical integration.

[14]Other inferences can be drawn for the design of competition policy in the international context by specifying which firms and what proportion of consumer demand fall within a particular regulatory jurisdiction. The model then enables us to identify the effects on welfare of domestic and foreign mergers. A similar idea is explored in Head and Ries (1997).

APPENDIX

Here it is shown how explicit solutions can be obtained for profits accruing to each unit under different market structures. To begin with, take the following general case:

There are $n = 0,1,2$ UI mines each of whom produces x^m units of crude,

$k = 0,1,2$ UI refineries each of whom produces y^r units of the final good using x^r units of crude, and

$h = 0,1,2$ VIFs each of whom produces y^v units of the final good using x^v units of crude.

UI *refinery r* chooses x^r to maximise its profits given by

$$\pi^r = p(Y)y^r - qx^r = (p - q)x^r ,$$

since $y^r = x^r$, given the assumption about the production function (A2). Note that q is the price of the intermediate good, taken as given by the refineries who are assumed to be competitive buyers in this market (A4). It is profitable for refineries to produce if $p - q > 0$, i.e. the price, p, is greater than the cost of producing a single unit of output, q. Given the assumption of Cournot conjectures (A3), each UI refinery also takes the output of other final good producers (UI refineries or VIFs) as given in the profit maximisation exercise, which yields the following first order condition

$$p + x^r p' - q = 0 ,$$

where p' is the derivative of the inverse demand function with respect to Y. It is assumed that the second order conditions for profit maximisation are fulfilled. Summing over k refineries, the following can be obtained:

$$p + \frac{X^r p'}{k} - q = 0, \qquad (1)$$

where $X^r = \Sigma x^r$ (summed over k) is the total input demand.

UI *mine m* chooses x^m to maximise its profits given by

$$\pi^m = q(X^r, p)x^m,$$

which are equal to total revenue since it has been assumed that crude production is costless (A2). The demand function facing the UI mines is the derived demand given by (1), i.e. the sum of the marginal revenues of the UI refineries. This follows from the assumed leadership position of the UI mines vis-a-vis the UI refineries (A4). Note that if there is only one UI mine and one UI refinery (the other two firms having chosen VI), then the former behaves as a monopolist vis-a-vis the latter. The first order condition for profit maximisation for each mine is

$$\frac{d\pi^m}{dx^m} = q + x^m \frac{dq}{dx^m} = 0,$$

or $$q + \frac{x^m}{k}((k+1)p' + X^r p'') = 0,$$

using equation (1) and recalling the Cournot conjecture, $\frac{dX^r}{dx^m} = 1$. Summing over n mines, the following is obtained:

$$q + \frac{X^m}{nk}((k+1)p' + X^r p'') = 0, \tag{2}$$

where X^m is the total input supplied by the mines.

The behaviour of the *VIFs* in the final good market is similar to that of the UI refineries as far as their conjectures about rivals are concerned, except that the unit cost of their inputs is zero and not q (from assumption A2). Each VIF v takes the output of its rival final good producers as given when it chooses x^v to maximise its profits given by

$$\pi^v = p(Y)y^v,$$

which are also equal to total revenue since there are no costs of production. The relevant optimising condition for each VIF is:

$$p + x^v p' = 0,$$

Summing over h VIFs, the following is obtained:

$$p + \frac{X^v p'}{h} = 0, \tag{3}$$

where X^v is the total crude used by VIFs for their own production.

The condition for equilibrium in the crude market is that

$$X^m = X^r, \tag{4}$$

i.e. the total quantity of input supplied by the UI mines is equal to the total quantity of input demanded by the UI refineries. Furthermore,

$$Y = Y^r + Y^v = X^r + X^v \tag{5}$$

i.e. the total output of the final good is equal to the sum of the outputs of the UI refineries and of the VIFs, which, given assumption A2, is equal to the total quantity of crude used by each type of firm.

Given assumption A1, i.e. the inverse demand function is linear and of the form $p = 1 - Y$, (1) to (5) can be solved to obtain the following:

$$p = \frac{1+k+n}{(1+k)(1+n)+h(1+k+n)},$$

$$q = \frac{1+k}{(1+k)(1+n)+h(1+k+n)},$$

$$x^r = \frac{na}{(1+k)(1+n)+h(1+k+n)},$$

$$x^m = \frac{ka}{(1+k)(1+n)+h(1+k+n)},$$

$$x^{v} = \frac{h(1+k+n)a}{(1+k)(1+n)+h(1+k+n)}$$

Now it is straightforward to find the solutions corresponding to different market structures by substituting the appropriate values for n, k and h. For instance, where no merger has taken place, $n = k = 2$ and $h = 0$; where a single vertical merger has taken place, $n = k = h = 1$, and so on. These solutions can then be substituted in the respective profit functions to obtain the values given in Table 1.

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Table1: Profits of merged and unmerged firms under alternative market structures

Outcome number	Market structure	Profits of indep. firms	Total industry profits	Price of the final good
(1)	(M_1+M_2)	0.1250	0.1875	0.75
	(R_1+R_2)	0.0625		
	(M_1+M_2)	0.1666		
(2)	R_1	0.0278	0.2222	0.67
	R_2	0.0278		
	M_1	0.0555		
(3)	M_2	0.0555	0.2222	0.67
	(R_1+R_2)	0.1111		
	M_1	0.0741		
(4)	M_2	0.0741	0.2469	0.56
	R_1	0.0494		
	R_2	0.0494		
	(M_1+R_1)	0.1837		
(5)	M_2	0.0408	0.2449	0.43
	R_2	0.0204		
	M_1	0.0408		
(6)	R_1	0.0204	0.2449	0.43
	(M_2+R_2)	0.1837		
(7)	(M_1+R_1)	0.1111	0.2222	0.33
	(M_2+R_2)	0.1111		

Note: M and R denote mine and refinery, respectively. The sign + denotes merger.

Table 2: Payoffs to the relatively dominant mines with simultaneous moves

		M_2		
		UI	VI	HI?
M_1	UI	**(4)** 0.0741, 0.0741	**(6)** 0.0408, 0.0918	**(4)** 0.0741, 0.0741
	VI	**(5)** 0.0918, 0.0408	**(7)** 0.0555, 0.0555	**(5)** 0.0918, 0.0408
	HI?	**(4)** 0.0741, 0.0741	**(6)** 0.0408, 0.0918	**(2)** 0.0833, 0.0833

Table 3: Payoffs to the relatively dominant mines with sequential moves

	(2) (M_1+M_2) R_1, R_2	**(4)** M_1, M_2 R_1, R_2	**(5)** (M_1+R_1) M_2, R_2	**(6)** M_1, R_1 (M_2+R_2)	**(7)** (M_1+R_1) (M_2+R_2)
Π^{M_1}	0.0833	0.0741	0.0918	0.0408	$0.0833-\varepsilon$
Π^{M_2}	0.0833	0.0741	0.0408	0.0918	0.0555

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